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PREDICTION OF VARIANCE IN NEURAL RESPONSE TO COCHLEAR IMPLANT STIMULATION AND ITS IMPLICATIONS FOR PERCEPTION

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Cochlear implant patients' perception of sound is derived via electrical pulses arising from an electrode array. Chosen aspects of the acoustic spectrum are coded via a stimulation pattern designed according to some sound coding algorithm. Thus, a patients' ability to discriminate between sounds, and in turn their speech understanding, is directly related to their ability to differentiate between the patterns of electrical stimulation which code various sounds. Is it possible to predict a patient's stimulation discrimination ability? Statistical theory indicates that a good measure of the discriminability of signals is the mean to standard-deviation ratio of response to the signals, with a higher ratio providing better discriminability. In this paper, the signal is electrical stimulation of the scala tympani with bipolar, biphasic current pulses, and the response is spike activity of individual auditory nerve fibres in the cat. We analyze experimental measurements of the mean, variance and standard-deviation of auditory nerve spike activity to a variety of electric stimulation conditions. In order to explain the mean to variance relationship, we apply a point process model of neural response. This model demonstrates that refractory properties of the neuron explain the experimental responses, and permits a prediction of neural response under arbitrary conditions. These results facilitate a prediction of the discriminability of variously coded sounds - permitting the design of new stimulation strategies which improve speech understanding.

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